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**International Chamber of Shipping
Oil Companies International Marine Forum**

Clean Seas Guide For Oil Tankers

The Operation of Load on Top

S/S CHEVRON CALIFORNIA

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FOREWORD

The Clean Seas programme, introduced by the oil and shipping industries in 1964 to restrict the operational discharge of oil into the sea, incorporated the now well-known concept of Load on Top.

This Guide, which describes the Load on Top procedures, is designed to help shipboard personnel to comply with the oil discharge limits contained in the 1969 amendments to the 1954 International Convention for the Prevention of Pollution of the Sea by Oil.

Effective Load on Top operation calls for complete understanding of the problem, strict adherence to the procedures, and vigilant supervision. Success depends upon full co-operation from all to whom this Guide is addressed:

the shipowner, who must ensure that all his ships are operated in accordance with the recommended procedures;

ships' personnel—both officers and crews—who must ensure that instructions are strictly complied with;

oil companies and others upon whom rests the ultimate responsibility for avoiding sea pollution; and

cargo shippers and receivers, who are also involved in these procedures.

The oil and shipping industries, through the Oil Companies International Marine Forum and the International Chamber of Shipping, strongly commend this Guide to all concerned.

INTRODUCTION

Not all oil pollution is caused by tankers. However, the huge volume of crude oil transported by sea has created a major problem in disposing of dirty ballast and tank washings without harming the marine environment or damaging coastal amenities.

It is this problem, associated with all persistent oils, with which this Guide is concerned.

Most crude oils contain wax and other materials in solution, together with sediments, which may settle out during the voyage and form a residue with any cargo remaining after discharge (of the order of 0.2 to 0.5 per cent of the cargo carried). If discharged into the sea in heavy concentrations in the course of tank washing the residue will stay on the surface for a long time and cause pollution.

Hence it must be kept on board and may be discharged at loading terminals where the necessary facilities are available. If not, the residue must be retained and the new cargo loaded on top. In no circumstances may the residue be discharged into the sea unless the safety of the ship or its personnel is at hazard.

Objects of Load on Top

The essential purpose of the Load on Top system is the collection and settling on board of the water and oil mixtures resulting from ballasting and tank operations—usually in a special slop tank or tanks—and their subsequent disposal ashore at the discharge port.

When oil and water are agitated together droplets of oil can enter the water and water can enter the oil. When oil droplets enter water they are generally well dispersed and will settle out, the rate depending upon the specific gravity of the oil and the size of the oil droplets.

Tank washing and pumping of wash water and oil residues produce water droplets which will enter the oil. Most crude oils contain emulsifying elements which hinder the separation of water dispersed in the oil. The oil residues in the slop tank generally contain this type of water-in-oil emulsion which is stable and long-lasting.

The 1954 Convention as Amended

All tankers can perform Load on Top operations as described in this Guide, which will enable them to meet the requirements of the 1954 Convention as amended in 1969.

The 1969 amendments impose a total prohibition on the discharge of any oil or oily mixture from a tanker within 50 miles of any coast, and limit the flow, concentration and quantity discharged anywhere else at sea.

Limited discharges may be made when the following conditions are satisfied:

- (i) "The tanker is proceeding en route".

(This eliminates the possible concentration of the permitted discharge from a stationary vessel or from a vessel steaming in tight circles, and ensures that the discharge is well-distributed.)

- (ii) "The instantaneous rate of discharge of oil content of any effluent shall not exceed 60 litres per mile".

(The "instantaneous rate" means the rate of discharge of oil content in litres per hour at any instant divided by the speed of the tanker in knots at the same instant. Experiment has shown that 60 litres per mile discharged in this way disperses rapidly and leaves no trace of oil on the surface of the water within 2 or 3 hours of discharge.)

- (iii) "The total quantity of oil discharged on a ballast voyage does not exceed 1/15,000 of the total cargo-carrying capacity".

(This puts a limit on the total amount of oil that can be discharged even at the reduced rate set out in (ii).)

- (iv) "The tanker is more than 50 miles from the nearest land".

(This is to make quite certain that the very small amounts of oil permitted to be discharged in compliance with requirements (ii) and (iii) will not reach the shore.)

Water effluent cleanliness is further discussed in the Annex.

These restrictions, all of which must be complied with, apply to crude oil, fuel oil, heavy diesel oil and lubricating oil. Discharges from pump-room bilges should be treated in a similar manner.

When a tanker is within 50 miles of land the only permitted discharge is clean ballast from a cargo tank which has been so cleaned that the effluent therefrom would produce no visible traces of oil on the surface of the water.

In the case of oil or oily mixtures from machinery space bilges, the requirements in (i) and (ii) above must be satisfied and additionally the oil content of the discharge must be less than 100 parts per 1 million parts of mixture, and made as far as possible from land. While there is no specified limit to the amount or the distance from land of the oil discharged from machinery space bilges, there is an absolute ban on the discharge of *any* type of oil in some territorial waters.

I PROCEDURES—THE BASIC METHOD

(A) Basic Method Assumptions

The procedures described in this Section assume that the tanker is using stripping pumps and has a single slop tank. This is the basic Load on Top method. Variations on this method entailing the use of eductors or more complex slop tank arrangements are described in Section III.

(B) Sequence of Procedures

- (a) Thoroughly drain cargo tanks and lines on completion of discharge.
- (b) Take on dirty ballast, thoroughly flushing cargo lines and pumps initially.
- (c) Wash cargo tanks and collect oily wash water in the slop tank.
- (d) Flush cargo lines where necessary.
- (e) Take on clean ballast.
- (f) Allow dirty ballast to settle.
- (g) Discharge “clean” part of dirty ballast to sea beyond 50 miles from nearest land.
- (h) Strip “dirty” part of dirty ballast to slop tank.
- (i) Flush the stripping system.
- (j) Settle and decant water from slop tank.
- (k) Discharge clean ballast.
- (l) Dispose of slop tank residues.

(C) Line Draining and Taking On Dirty Ballast

- 1. All lines containing cargo should be pumped ashore on completion of discharge. This involves opening cross connections between cargo and stripping lines.
- 2. Any remaining cargo in the lines which cannot be pumped ashore should be drained into a separate tank or into the tank chosen as the slop tank before ballasting begins. Where the ship has no special slop tank the aftermost centre cargo tank is frequently used for this purpose.
- 3. Dirty ballast should then be taken on, making sure that a pump is started before opening the main sea valve. In the process all cargo lines should be flushed.

(D) Tank Washing

4. Cargo tanks should next be washed and contents stripped to the slop tank. Care should be taken to ensure that wash water does not build up on the tank bottom.
5. It should be understood that the quantity of oil discharged to the sea can be minimised by eliminating unnecessary washing, thus minimising the quantity of water brought into contact with oil within the tanker.
6. As the clean ballast is to be discharged directly to the harbour it is imperative that the tanks in which it is carried are clean.

(E) Loading Clean Ballast

7. Before starting to load clean ballast make sure that the main cargo pumps and lines are clean by further flushing into a suitable dirty ballast tank or slop tank.

(F) Settling of Dirty Ballast

8. A good oil/water separation of the dirty ballast takes time, depending upon the movement of the ship as well as on the previous type of oil cargo carried. Under favourable conditions it may take no more than 12 hours. But in most circumstances 24 hours or more are needed to achieve optimum results.

(G) Disposal of Dirty Ballast

9. When settling is complete the ballast tanks will contain water with an oil layer on top. The bulk of this water may now be discharged to the sea, preferably when the vessel is steady, applying the following procedures:
 - (a) If necessary, flush main cargo lines and pumps into a dirty ballast tank or slop tank.
 - (b) Start to discharge ballast water.
 - (c) Reduce discharge rates from individual tanks on approaching a water depth of about 15 per cent of the tank depth.
 - (d) Slow down pumping rates to avoid drawing surface oil into the suction by vortex or weir effects.
 - (e) Stop discharge of individual tanks when a level has been reached which, for the particular ship, is known not to give rise to any entrainment of oil. When all tanks have been discharged to this level all discharge overboard must cease.

- (f) At this stage the officer in charge should verify that the slop tank can take the volume of dirty ballast remaining. If ullage is insufficient, then the slop tank may be partially discharged to provide the necessary capacity, taking care to ensure that an adequate depth of water remains beneath the oil residue layer.
- (g) Start transferring the remaining dirty ballast into the slop tank, using the stripping system.
- (h) Before final clean-up, transfer to the slop tank the contents of the pump room bilges and any other bilges connected to the cargo stripping system.
- (i) The stripping system will then be dirty and should be flushed into the slop tank.

(H) Slop Tank Discharge

10. Decanting of the slop tank contents is a critical step in the Load on Top operation.
11. Hence the timing of the various steps in the operation is important. Even a short delay in stopping a pump or closing a valve can allow a significant quantity of oil to escape into the sea.
12. As with dirty ballast, the time required for oil and water to separate in the slop tank depends upon the motion of the ship as well as on the type of previous cargo.
13. Under favourable conditions a few hours may be enough, but longer periods are desirable. In most circumstances, 36 hours or more should be allowed.
14. Before starting discharge an accurate interface and ullage reading must be taken to determine the depth of the oil layer.
15. The interface profile may vary over several inches in depth. Hence, discharge from the tank must cease well before the measured interface is reached to avoid discharge of any oil-in-water emulsion overboard.
16. Although every effort should be made to remove as much water as possible from the slop tank, the prime objective is to prevent oily water reaching the sea.
17. Extreme care is therefore necessary, and the overboard discharge must be closely checked.

18. Agitation of the slop tank contents must be kept to a minimum to avoid drawing surface oil into the suction by vortex or weir effects, particularly as the oil/water interface approaches the top of the structural members in the tank bottom. Pumping rates must be strictly controlled.

The following detailed procedures should be followed:

- (a) Pump down the slop tank using one main cargo pump at slow speed until a water depth of about 15 per cent of the tank depth is reached.
- (b) Stop the cargo pump, then take an oil/water interface and ullage reading and re-calculate the remaining water depth.
- (c) Resume pumping of the slop tank, this time using a stripping pump, until a predetermined water depth is reached which, for the particular size and construction of the slop tank, is known not to give rise to discharge of oil. Pumping, which may initially be at a moderate rate, should be slowed as this predetermined water depth is approached. Check visually (or by instruments) for any signs of oil in the water issuing from the stripping pump drain cock.
- (d) If oil should appear before the predetermined water depth is reached, stop pumping.
- (e) Should this occur, further settling of the slop tank contents should be allowed for as long as possible before repeating steps (c) and (d).
- (f) No decanting must take place beyond the predetermined water depth.

(I) Final Line and Pump Flush

19. As an added precaution, after these operations have been completed and while the ship is still more than 50 miles from any coast, the lines and pumps which will be used to discharge clean ballast must be thoroughly flushed to sea.

(J) Discharging Clean Ballast

20. If the tank washing has been carried out as described, there should be no risk of any oil being discharged overboard in the loading port. Nevertheless, the ballast outlet should be watched, particularly when draining a tank bottom, as this is the most likely time for oil to be picked up. If this happens discharge must be stopped immediately and the remainder in the tanks stripped to the slop tank.

(K) Disposal of Slop Tank Residues

21. Before reaching the loading port the master should advise his owners or charterers of the amount of retained residues on board. These may be disposed of in several ways:
 - (a) Pump the residues ashore at the loading terminal, subject to reception facilities being available.
 - (b) Retain the residues on board and load the new cargo on top of them.
 - (c) Retain the residues on board, but segregated from the new cargo. If this is done, it may be possible to pump them ashore at the discharge terminal, if reception facilities are available. It may, however, be necessary to carry them forward for more than one voyage.

(L) Handling Sludge

22. Only small quantities of sludge should remain in the cargo tanks after machine washing.
23. Most of the sludge that accumulates on tank bottoms and internal structures can be stripped to the slop tank and discharged later, together with the next cargo or to shore reception facilities.
24. Should areas of heavy sludge build-up be found after initial tank washing, they are better dealt with by specially locating tank washing machines and re-washing with very hot water than by immediately resorting to hand lifting.
25. In this manner much of the sand, scale, sediment and oil can be transferred to the slop tank, thereby minimising removal by hand.
26. The small amount of sludge that is found after efficient cleaning is composed principally of scale, sand, water, wax and sediments of various kinds.
27. When sludge containing oil or oil residue is recovered by hand, the material should be retained on board in suitable containers and disposed of ashore.
28. Scale or sediment that clearly has no oil content may be dumped directly overboard. If the presence of oil in the sludge is in doubt, however, it must be kept on board.

II OPERATIONAL FACTORS INFLUENCING BASIC METHOD

(A) Short Haul Voyages

1. The Load on Top operation takes time. The fact that tankers on short haul voyages have only limited time is no excuse for curtailing or bypassing the procedures if this results in oil being discharged into the sea.

Several possibilities are available:

- (a) Eliminating tank washing and discharging dirty ballast at the loading terminal.
- (b) Washing ballast tanks at the discharge terminal and sailing with clean ballast.
- (c) Segregating ballast in some cargo tanks as a temporary trading measure.
- (d) Re-routeing the ship or slowing down to allow enough time for proper Load on Top procedures.

(B) Coastal Voyages

2. If a tanker's passage between her discharge port and the next loading port is wholly within 50 miles of the coast, no discharge associated with a Load on Top operation is permitted.
3. All dirty ballast and cargo tank washings must be discharged at the loading port if reception facilities are available.
4. Otherwise, tanks must be cleaned alongside the discharge terminal (provided it has reception facilities); some cargo tanks temporarily assigned to segregated ballast; or the ship diverted to a port with the necessary shore reception facilities.
5. If a Load on Top operation must be carried out, then the ship must go beyond the 50-mile limit to decant the water from the ballast and slop tanks.

(C) OBO and Ore/Oil Carriers

6. For the purpose of this Guide, OBO and Ore/Oil carriers when engaged in the carriage of oil can be considered as tankers, and therefore in the main the basic Load on Top method applies to them.

7. However, these vessels are generally equipped with two inter-connected slop tanks. Variations on the basic method using more than one slop tank are described in paragraph (B), page 12.
8. OBO and Ore/Oil carriers transferring from oil to dry bulk trades are obliged to clean the entire cargo system. The large quantities of oil residues resulting have subsequently to be disposed of ashore.
9. Various means for the disposal of these residues are open to the owner for consideration:
 - (a) All residues are retained on board, and discharged ashore at the loading port.
 - (b) If reception facilities are not available at the loading port then a deviation can be made to a port where these facilities exist.
 - (c) If (a) and (b) are not possible, all residues are retained on board, thereby incurring deadfreight on the loaded passage.
 - (d) The vessel is cleaned before departure from the discharge port and all washings are discharged ashore.
10. Operators of OBO and Oil/Ore carriers are particularly reminded of safety regulations in some dry bulk cargo loading and discharging ports relating to vessels having oil residues on board.

(D) Preparation for Repair Ports

11. A more intensive tank cleaning programme carried out in advance of the repair period will reduce the amount of oily residue and sludge which has to be removed from cargo tanks on the voyage to the repair port.
12. Some crudes help to dissolve sludge, and it is useful where practicable to carry a cargo of such a crude on the last voyage before the ship goes in for repair.
13. Several options are open to owners with ships cleaning for repair, depending upon the length of the voyage and the ship's route from her discharge terminal:
 - (a) Cleaning ballast tanks at discharge terminal and pumping the tank washings to shore reception facilities.
 - (b) Performing a basic Load on Top operation and retaining the residues for discharge to shore reception facilities at the repair port or intermediate port.

- (c) Using a tank cleaning berth either at the repair port or intermediate port for all or part of the cleaning operation.
- 14. Owners should ensure that the port has shore reception facilities with enough capacity to take the slops collected on board, together with the washing water necessary to clean the slop tank. Before arrival the Master should indicate how much dirty ballast water (if any) the ship has on board, the grade of the last cargo, and the amount of oil residues and sludge for disposal.
- 15. Where repair port reception facilities are inadequate or non-existent, permission may be given to inert the slop tank during the repair period. On putting to sea the retained slops will be processed by the basic method.

III OTHER FACTORS INFLUENCING BASIC METHOD

The basic method may have to be modified because of shortcomings in existing equipment, or because the ship has additional equipment not hitherto discussed. The variations in procedure are discussed below:

(A) Insufficient Slop Tank Capacity

In this eventuality tank washing will have to be interrupted to allow time for the proper settling and decanting of part of the slop water content (see paragraph (H), page 7).

(B) Multiple Slop Tanks

Two interconnected slop tanks will provide additional stages in the gravity separation process. The primary tank will be allowed to fill with tank washings and residues until a level is reached at which the liquid will start to run into the secondary tank.

The first stage of separation will then have taken place, with oil floating on the surface of the primary tank, and either clean water or water with a low oil content flowing into the secondary tank.

The secondary tank will be allowed to fill to about 80 per cent of capacity. An oil/water interface should then be determined and the water content run into the sea. Some tankers may have a third slop tank, enabling a further stage of gravity separation to be used. Provision of multiple slop tanks may enable continuous flow decanting to take place.

(C) Continuous Flow Decanting

By this method the slop tank continuously discharges by gravity while simultaneously receiving cargo tank strippings. Since oil/water separation takes time and is affected by tank and piping configuration, this method is not recommended unless the system has been verified as producing an acceptable discharge.

**(D) Eductors
Open Cycle**

The use of eductors on open cycle is not recommended. Drive water is taken from the sea, and the large quantities which have to be processed may exceed the holding capacity of the slop tank.

The more water used, the greater the total oil outflow, even in low concentrations.

Partial Recirculation

The eductor drive water is drawn from the bottom of the slop tank while water direct from the sea is used for cargo tank washing. Hence the total quantity of water will be less than for open cycle and may eliminate the problem of insufficient slop tank capacity.

Full Recirculation

All the water required for cargo tank washing and eductor drive is drawn from the bottom of the slop tank. Hence the total amount of water used is limited to that pre-loaded into the slop tank. If the tank atmosphere is uncontrolled during the washing process then internationally accepted safety recommendations apply.

(E) Slop Tank Heating Coils

Heating coils may be installed suitably located to heat and separate water in the emulsion layer.

(F) Oil/Water Separators

Separators may be fitted to process dirty ballast water and settled water from slop tanks. They should be capable of high throughputs.

Most separators are of the gravity type, relying upon the difference in density between oil and water for separation. They are capable of reducing the oil content of water to be discharged overboard, but the standard of separation achieved depends to a large extent upon the

pumping rate into the separator. Separators are designed to separate oil droplets from water; they will not separate oil and water from stable water-in-oil emulsions. Because the specific gravity of these emulsions approaches that of sea water, there is a risk that the emulsion could be forced over into the clean water outlet.

(G) Oil Content Meters

Fitting an oil content meter (or trace detector) in an overboard discharge line permits continuous monitoring of the quality of the water being discharged. It may be equipped with visual or audible warning signals to assist the operator.

(H) Oil/Water Interface Detectors

Oil/water interfaces are usually located by the use of a modified ullage tape which works on the principle that salt water conducts electricity. Current is produced electrolytically by the difference in electric potential between a zinc insert in the tape weight and the steel structure of the tank. No batteries are required. If no deflection of the meter needle occurs even when the zinc tip is known to be well down into the water layer, this may be due to poor contacts in the circuit. These may be caused either by:

- the clamp not making an adequate contact with the steel rim of the ullage hole;

or

- the zinc tip being coated with cold, heavy or waxy oil, thus preventing zinc/water contact.

To operate the instrument:

- lower the brass weight until it is well within the water layer, when the needle should give full deflection and then withdraw slowly until the oil/water interface is indicated by a return of the needle to zero;

or

- place the brass weight into a sample can filled with clean water, and lower the can and weight through the oily layer into the water layer. When the meter needle deflects, lower the sample can away from the brass weight and raise the weight slowly. The interface is indicated when the needle returns to zero.

Another means of determining water levels in dirty ballast and slop tanks is to use water-finding paste or ribbon. This is not recommended because

the paste colour and ribbon markings may be obscured or obliterated as the tape is withdrawn through the oil.

(I) Tank Cleaning Chemicals

Chemical additives are available which will speed up the tank cleaning process. They are useful in short haul voyages and in preparation for repair ports. They are injected into the tank cleaning water, and are most effective when used in water heated to about 65°C.

This temperature may have to be adjusted to take account of possible damage to cargo tank coatings. It should be noted that the use of chemicals is subject to internationally accepted safety recommendations applicable to ships in which the tank atmosphere is uncontrolled during tank washings.

(J) Demulsifiers

Oil residues accumulated in a slop tank from ballasting and tank cleaning operations nearly always contain water-in-oil emulsions which are extremely persistent. They can be broken by demulsifiers, a process improved by the use of heat. The length of time heat is applied is more important, however, than the temperature reached.

IV RESPONSIBILITIES

Responsibilities for complying with the procedures outlined in this Guide rest with many people. By far the most important are the Charterer, Owner, Master and Cargo Receiver.

The **Charterer** should include in the Charter Party a clause stating his policy on oil pollution prevention, and requiring the tanker to operate in accordance with the procedures set out in this Guide.

The **Owner** should:

- (a) Co-operate fully with the Charterer in measures to avoid pollution.
- (b) Provide detailed instructions for each of his vessels, based on the principles and procedures set forth in this Guide, to satisfy variations in construction and equipment.
- (c) Leave Masters in no doubt that he supports these measures.
- (d) Satisfy himself that the procedures set out in this Guide will be correctly applied by means such as voyage reports.

- (e) Arrange training programmes to instruct personnel in these procedures.

The **Master** should ensure that his crew are fully proficient in carrying out the procedures laid down in this Guide and that they apply them carefully and conscientiously. He must notify the owner and seek his advice about circumstances which might impair his ability to comply with the procedures.

The Master should attach just as much importance to the correct keeping of the Oil Record Book as of the ship's Official Log Book. Entries must be accurate and should be made as soon as possible after any part of a Load on Top operation has been completed.

The Master should regard the Oil Record Book as important evidence in establishing whether or not he has contravened the regulations concerning oil discharge, and should remember that the Book may be inspected by government officials.

Entries may also be made in the Ship's Log Book to cover associated entries in the Oil Record Book regarding time of commencement and completion of discharge, and any other pertinent details.

Cargo Receivers must be prepared to accept tank cleaning slops, or cargo that has been commingled with retained oil residues. They must be prepared to advise both shore and ship management of any requirements to segregate retained slops from incoming cargo.

ANNEX

Water Effluent Cleanliness Requirements

The 60 Litres Per Mile Criterion

Any tanker sailing in normal weather conditions can keep within the oil discharge rate limit of 60 litres of oil per mile of ship travel; oil discharged at this rate quickly spreads to a thin film which disappears as detectable contamination within two or three hours.

Contamination of the surface of the sea behind a discharging ship depends initially on:

- (a) the effluent discharge rate,
- (b) the oil content of the effluent,
- (c) the ship's speed.

The oil discharge rate in litres per mile is given by:

$$\frac{(\text{ppm of oil in effluent}) \times (\text{effluent discharge rate in m}^3/\text{hour})}{(\text{ship's speed in knots}) \times 1,000}$$

Different combinations of effluent discharge rates, effluent oil contents and speeds can clearly produce similar oil discharge rates. Consider, for example, a large tanker travelling at 15 knots. Discharge of the clean part of the dirty ballast water at, say, 8000 m³/hour and an oil content of 30 ppm gives an oil discharge rate of 16 litres per mile. An identical discharge rate would be obtained during the final slow discharge of the slop tank water as the oil/water interface nears the pump suction, if the effluent discharge rate and oil content were 80 m³/hour and 3000 ppm respectively.

The 1/15,000 of the Total Cargo-Carrying Capacity

This requirement in association with the 60 litres/mile limit effectively prohibits the discharge to the sea of bulk residues.

It must be appreciated that this limit of 1/15,000 includes the amount of oil in the clean water discharged from the dirty ballast tanks and the oil content

of the water discharged from the slop tank. Due allowance must therefore be made to avoid exceeding this total limiting amount.

The volume of oil in m³ put to the sea in any effluent is given by:

$$\frac{(\text{volume of effluent in m}^3) \times (\text{oil content in ppm})}{10^6}$$

Load on Top Effluent Characteristics

The effluents from Load on Top operation have distinct characteristics:

- (a) The discharge of the bulk of the settled dirty ballast. This effluent is characterised by a high flow rate, large in quantity but of low oil content. Oil content in good weather is typically around 30 ppm, but higher oil content may be expected if there is substantial ship movement.
- (b) The discharge of the bulk of the settled water from a slop tank. This is characterised by a moderate discharge rate, moderate quantities and moderate oil content. Oil content in good weather may be typically around 150 ppm, but again higher oil content will occur in heavy weather.
- (c) The slow discharge of slop tank water as the oil/water interface nears the tank suction. This effluent is characterised by very low discharge rate, low quantity but probably of substantial oil content, particularly in the last stages just before visibly discernible oil discolouration appears in the effluent. An average oil content of around 500 ppm is typical, rising sharply to double this or more as the effluent becomes discoloured. Stopping further discharge at this point will always leave a water bottom in the tank the depth of which will vary with ship movement and the shape and structure of the tank bottom.

